North Carolina Estuarine Shoreline Mapping Project

SCDHEC Shoreline Change Advisory Committee

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Charleston, SC

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Growing Concerns along the Estuarine Shoreline

- Shoreline stabilization increasing
- Tracking of those structures
- CAMA shoreline stabilization regulations
- Lack of understanding of impacts
- Delineated shoreline never done for NC

Coastal Hazards Enhancement Area

- 5-year Strategic Plan
- TASK: Initiate Development of a Statewide Estuarine Shoreline Mapping and Assessment Plan to facilitate review and revision of the Estuarine Waters Area of Environmental Concern

DCM Estuarine Mapping Focus

- Shoreline Mapping

- Structure Mapping

- Attributing
  - Shoreline Type
  - Structure Type
  - Possibilities for use …..
    - Erosion rates
    - Habitat changes
    - Status and trends analysis

Estuarine Shoreline Mapping-Pilot Project

- Contract with CGIA to determine the possibility of automating the process

- Carteret, Craven, and Pamlico counties

- Shoreline delineation, shoreline type and structure inventory

- Feature Analyst - extraction tool through ArcGIS extension

Results of Pilot Study/Contract *(August 2007)*

- Given the editing required with extracted features, digitizing structures takes less time than extraction (plus editing).

- Visual interpretation is valuable where boats are adjacent to docks, where parallel structures are narrow in width, and where perpendicular structures are only a few pixels wide.

- Determined that we would use "heads-up" digitizing

ESM Summit Survey Results *(December 2007)*

- Survey Monkey
- 30 survey participants
- 60% managers, 40% technicians
- 54% of respondents agencies map estuarine shorelines
- Participants include: USGS, NOAA, East Carolina University, NC State University, NC Department of Transportation, Albemarle-Pamlico National Estuary Program, Division of Marine Fisheries, Division of Environmental Health, Division of Coastal Management, Division of Water Quality, Division of Water Resources, Sea Grant, Center for Geographic Information and Analysis, DENR Information Technology Services, and Geodynamics LLC.

CAMA Counties

Beaufort – APNEP, ECU, DEH

Bertie – APNEP, ECU, DEH

Brunswick – NCCR, DEH

Camden – APNEP, ECU, DEH

Carteret – APNEP, ECU, DEH, NCCR

Chowan – APNEP, ECU, DEH

Craven – APNEP, ECU, DEH

Currituck – APNEP, ECU, DEH, NCCR

Dare – APNEP, ECU, DEH, NCSU

Gates – APNEP, ECU

Hertford – APNEP, ECU

Hyde – ANPEP, ECU, DEH

New Hanover – DEH, NCCR

Onslow – DEH

Pamlico – APNEP, ECU, DEH

Pasquotank – APNEP, ECU, DEH

Pender – DEH

Perquimans – APNEP, ECU, DEH

Tyrrell – APNEP, ECU, DEH

Washington – APNEP, ECU
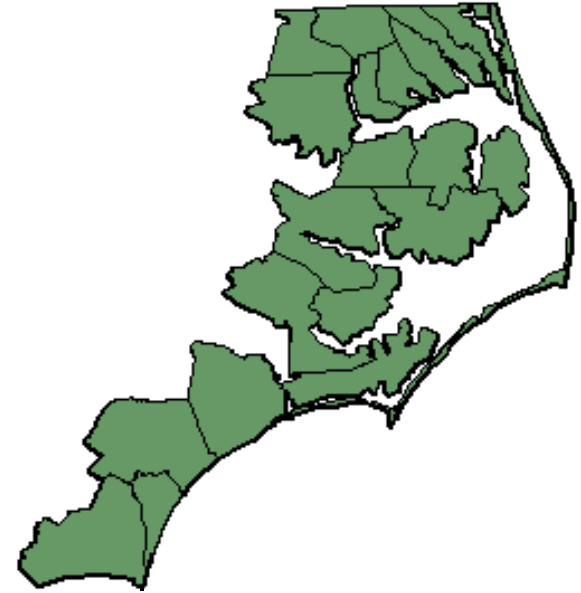
NOAA and DMF map in all 20 CAMA counties

Methodology used to map the shoreline?

- 86% Aerial Orthophotography interpretation (digitizing)
- Other (combinations with above)
  - 36% GPS-based field data collection
  - 36% LIDAR-based interpretation
  - 29% Imagery-based spectral analysis

Do you use estuarine shoreline data as part of your job?

- 77% Yes

How do you use estuarine shoreline data?

- Defining shellfish closing areas
- Report mileage to the EPA
- Planning compliance, use support assessment
- Academic research
- Shoreline change rates
- NC Strategic Conservation Plan
- Mapping location of pollution sources

DCM Estuarine Shoreline Delineation Methodology

Project Goals
BIG PICTURE

- Provide data needed to examine existing DCM policy within its estuarine & ocean system AECs;

- Study ecosystem function & cumulative impacts;

- Use data to research shoreline change & erosion rates;

- Quantify extent of various land-water interfaces;

- Understand cumulative effects of hardening estuarine areas.

Questions to ask?

- How many miles of estuarine shoreline are in NC?

- How many miles of estuarine shoreline are hardened?

- How many recreational structures (i.e. docks & piers) are present along the estuarine shoreline, and to what extent do they cover NC public trust waters?

- Can an accurate quantification be made concerning estuarine habitat loss due to shoreline hardening?

Estuarine Shoreline Mapping

Develop a methodology to delineate a contiguous estuarine shoreline for NC.

3 MAIN COMPONENTS

1. Delineated shoreline: digital representation of the land/water or vegetation/water interface

2. Characterization of shoreline type (i.e. marsh, sediment bank, swamp forest, modified, miscellaneous)

3. Inventory of erosion control, recreational and commercial shoreline structures

DCM Criteria

1. Most recent datasets
   (county aerial orthophotos)

2. Highest resolution (increased accuracy)
   (6 inches to 2-foot resolution)

3. Color imagery

4. Leaf-off imagery

Digitizing Rules

- Default = approximate land/water or vegetation/water interface

- Scale: 1:300 to 1:500 feet range

- Technicians will not digitize shorelines outside of the 20 CAMA counties

- Stream width of 20 feet will serve as a guideline for where digitizing efforts will stop (consistent w/ NC Stream Mapping Program)

Imagery

imagery will be georeferenced
* data in 6-inch & 2-ft resolutions
** data in 6-inch, 1-ft & 2-ft resolutions

Imagery Name	Most Current Date	Resolution	Image Type	DCM In House	Next Available	Statewide
Beaufort County Aerial Orthophotos	2007	6 inch *	True Color	No	Unknown	No
Bertie County Aerial Orthophotos	2003	6 inch*	True Color	No	Unknown	No
Brunswick County Aerial Orthophotos	2004	6 inch	True Color	No	2008	No
Camden County Aerial Orthophotos	2003	6 inch*	True Color	No	2008	No
Carteret County Aerial Orthophotos	2004	6 inch**	True Color	Yes	2009	No
Chowan County Aerial Orthophotos	2000	6 inch*	True Color	No	Unknown	No
Craven County Aerial Orthophotos	2007	6 inch*	True Color	Yes	Unknown	No
Currituck County Aerial Orthophotos	2003	6 inch	True Color	Yes	2008	No
Dare County Aerial Orthophotos	2007	?	True Color	Yes	2007	No
Gates County Aerial Orthophotos	2003	6 inch*	True Color	No	Unknown	No
Hertford County Aerial Orthophotos	2004	6 inch*	True Color	No	2014	No
Hyde County Aerial Orthophotos	2006	6 inch	True Color	Yes	Unknown	No
New Hanover County Aerial Orthophotos	2006	6 inch	True Color	Yes	Unknown	No
Onslow County Aerial Orthophotos	2006	6 inch	True Color	Yes	Unknown	No
Pamlico County Aerial Orthophotos	2002	6 inch*	True Color	No	2008	No
Pasquotank County Aerial Orthophotos	2003	6 inch*	True Color	No	2008	No
Pender County Aerial Orthophotos	2003	6 inch*	True Color	No	2008	No
Perquimans County Aerial Orthophotos	2003	6 inch*	True Color	No	2008	No
Tyrrell County Aerial Orthophotos	2007	1 foot	True Color	Yes	Unknown	No
Washington County Aerial Orthophotos	2004	6 inch*	True Color	No	Unknown	No
NAIP 2005 Imagery	2005	2 meter	True Color	No	2009?	Yes
NAIP 2006 Imagery	2006	1 meter	True Color	Yes	2009?	Yes
Post-Isabel Photography	2003	2 foot	Black & White	Yes	NA	Yes
CGIA Aster Satellite Imagery	2005	15 meter	Multispectral	No	Unknown	No
SAV Mapping Imagery	2007-2008	1 Meter	Multispectral	No	Unknown	No

Shoreline Type Attribution
5 shoreline types

- Using Riggs' (2001) classification as a guide, a list of shoreline types was developed by the NC Estuarine Shoreline Biological and Physical Processes Work Group.

- We grouped list further for ESMP: *Swamp Forest, Marsh,* and *Sediment Bank*.

- Additional shoreline types: *Modified* and *Miscellaneous*

Shoreline Type Attribution
(shoreline, type & structures)

1. Heads-up digitizing from county-level aerial orthophotographs
   - county-by-county approach
   - approximated under docks, piers & structures overlapping shoreline

2. Segment shoreline dependent on shoreline type
   - visual clues from orthophotos
   - wetlands vegetation land-cover polygon shapefile

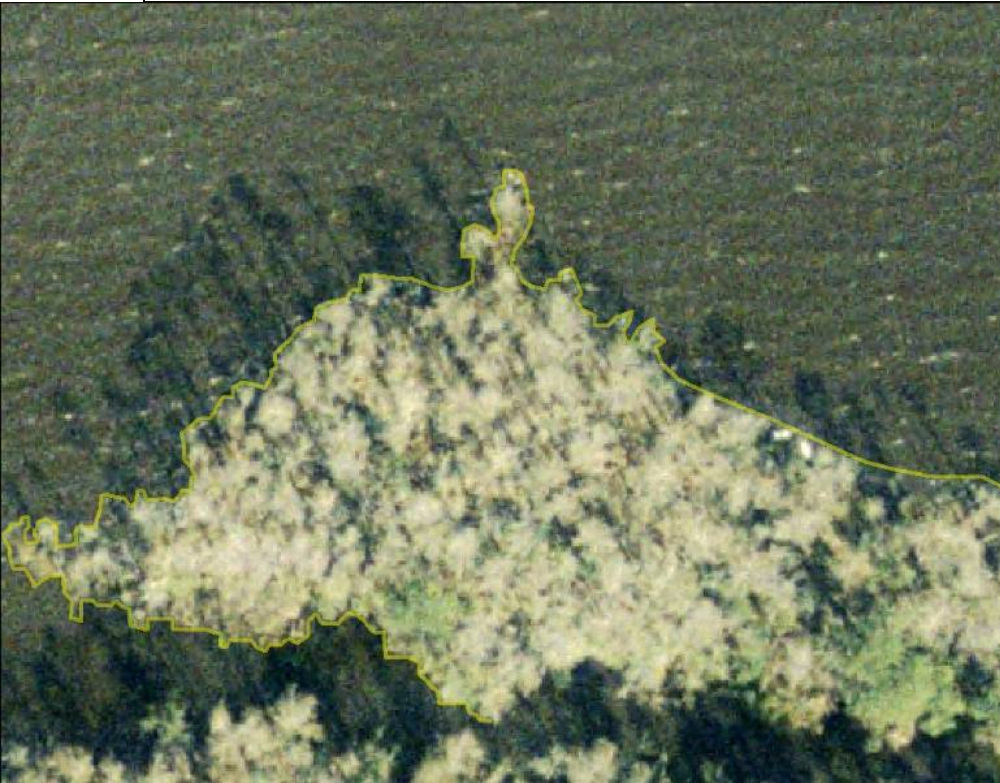3. Capture shoreline structures in a separate structure shapefile

Shoreline Type: Marsh
(vegetation/water interface or waterward edge of vegetation)

Shoreline Type: Swamp Forest
(mainland tree canopy to represent shoreline)

Shoreline Type: Sediment Bank
(wet/dry line represented by boundary b/t wet & dry sand)

Wet/Dry Line

Wet/Dry Line

Shoreline Type: Modified with Engineered Structure

- Types of structures (9 groups)
- Structure Delineation Methodology
  - Polyline (breakwaters, groins, jetties)
  - Polygon (boat ramps, piers, docks)
  - Unknown (may need ground truthing?)

Structure Groups	Structure Type Category	Shapefile Type
Boat Ramp	boat_ramp	Polygon
Breakwater	Breakwater	Polyline
Bridges	Bridge	Polygon
Groins and Jetties	groin_jet	Polyline
Piers, floating docks (including ramps) and wharfs	pier_fd_wharf	Polygon
Sill	Sill	Polyline
Sloped structures	Sloped	Polyline
Unknown	Unknown	Polyline or Polygon
Vertical structures	Vertical	Polyline

# Shoreline Type: Modified with Engineered Structure

Shoreline Type: Miscellaneous

- Inland county boundaries

  (coastal county shoreline crosses into inland county)

- Boundary between two coastal county shorelines

- Upstream extent of rivers

  (20 foot rule)

Next Steps

- Current contract with East Carolina University to map 2 counties ($15,500) by June 2009.

- Develop long-range plan (identify staff, time, money, equipment, contractors) to complete all 20 counties by June 2011.

- Implement mapping project.

QUESTIONS?
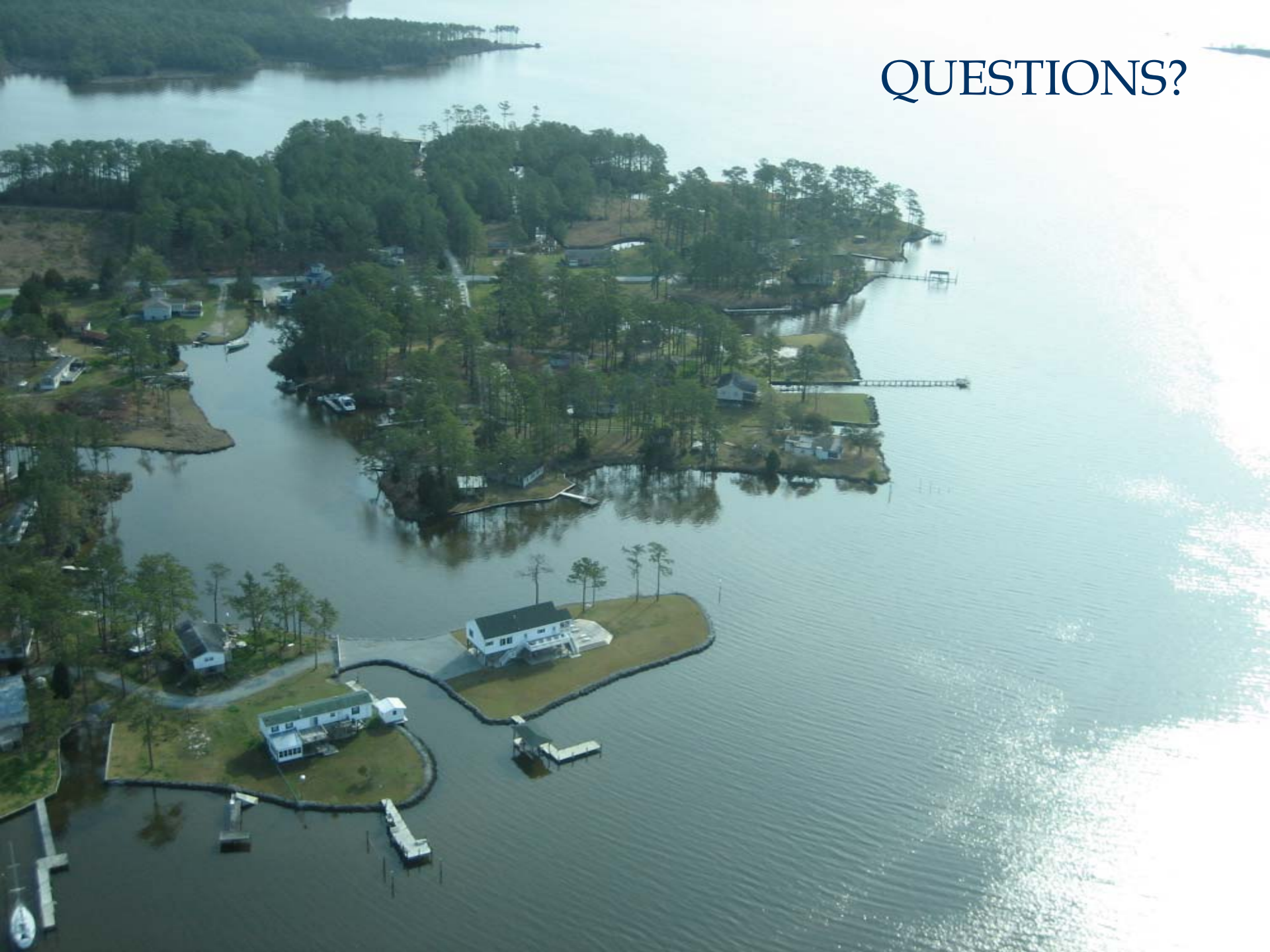
Coastal Zone Enhancement Grant-Section 309 CZMA

- Designed to encourage states and territories to develop program changes in one or more of nine coastal zone enhancement areas.

- Every 5 years, conduct a self-assessment of their coastal management program activities within each enhancement area.

- Based on program assessment, develop a five-year strategy to achieve enhancements to the high priority program areas.

C-DAITS
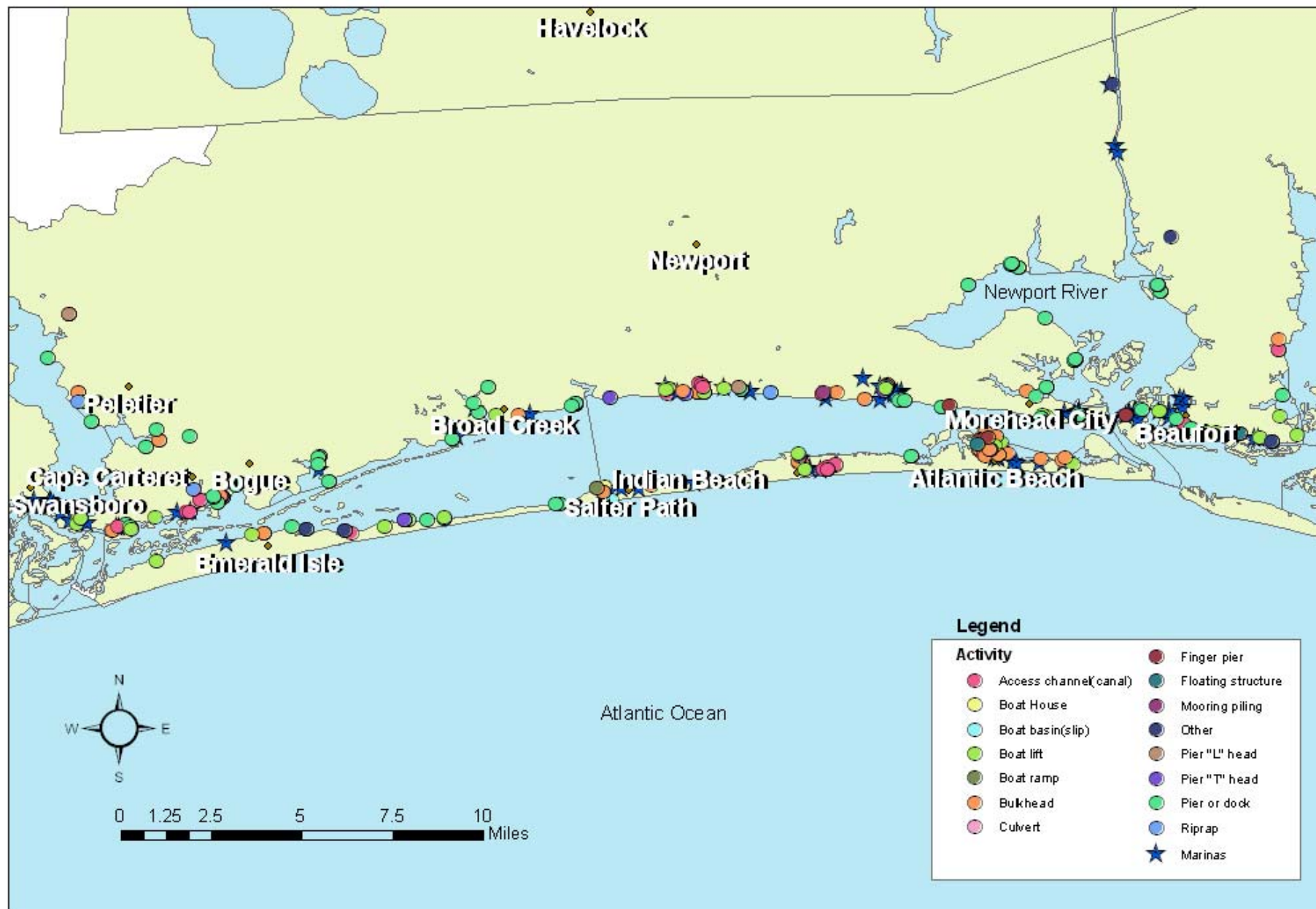## *Coastal Development Activity and Impact Tracking System*

- DCM developed a strategic plan to improve its ability to identify and manage cumulative and secondary impacts of coastal development.

- A more accurate and comprehensive tracking of coastal development activities and impacts was necessary to begin understanding the magnitude, number, location, and distribution of these human disturbances to the coastal environment and their proximity to sensitive natural resources.

C-DAITS
Coastal Development Activity and Impact Tracking System

- A database for capturing CAMA authorized development activities, development impacts and coastal resource information, integrated with a Geographic Information System, and interfaced with a user-friendly set of interactive tools for querying and reporting.

2004 Permitted Activities by Type for Bogue Banks Area

Havelock

Newport

Newport River

Peletier

Broad Creek

Morehead City

Beaufort

Cape Carteret

Bogue

Swansboro

Indian Beach

Atlantic Beach

Salter Path

Emerald Isle

Atlantic Ocean

N
W E
S

0   1.25   2.5   5   7.5   10
Miles

Legend

Activity

- 🔴 Access channel(canal)
- 🟡 Boat House
- 🔵 Boat basin(slip)
- 🟢 Boat lift
- 🟢 Boat ramp
- 🟠 Bulkhead
- 🟣 Culvert
- 🔴 Finger pier
- 🟢 Floating structure
- 🟣 Mooring piling
- 🔵 Other
- 🟤 Pier "L" head
- 🟣 Pier "T" head
- 🟢 Pier or dock
- 🔵 Riprap
- ⭐ Marinas

What are your estuarine shoreline data needs

- 75% - Updated and accurate shorelines
  - Other
    - Consistent products with known definition of the shoreline
    - Relatively frequent updates to reflect changing conditions
    - Anything I can get

What are limitations and deficiencies of the shoreline data you currently use

- 92% - Not enough accuracy, out of date

What would enable you to better map the estuarine shoreline

- 82% - Better Imagery (current)
- 55% - More Funding
- 63% - More Time
- 36% - More Training

ESMP Products

1. A contiguous estuarine shoreline for NC
   - Categorized by shoreline type
   - Easily distributed to stakeholder agencies

2. A coastal structures inventory
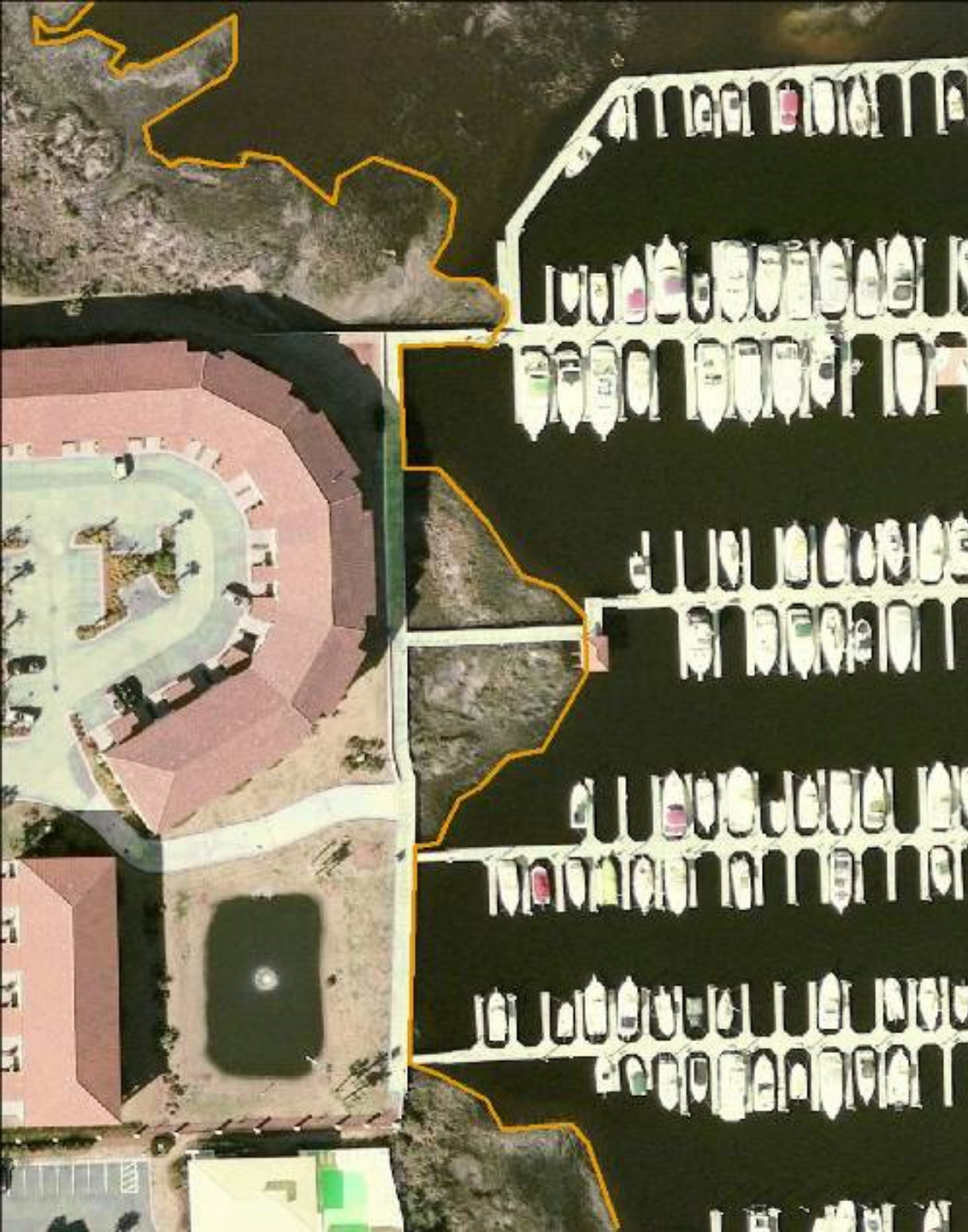   - Categorized by structure type

Stakeholders

- State Level – Division of Marine Fisheries, Division of Water Quality

- Federal Level – NOAA

- Academics – East Carolina University, Duke University

- Non Profits – Albemarle Pamlico National Estuarine Program

Shoreline Type: Marsh

Varying Shorelines

Shoreline Type: Modified with Engineered Structure

- Two shapefile categories:
  1. <u>Polyline Features</u>: Structures that stabilize the shoreline in any way (breakwaters, groins, jetties).

  2. <u>Polygon Features</u>: Structures that are recreational or commercial in use, provide direct access to the water, and have a discernable length and width (bridges, piers, docks).

Attribute Data

Attribute	Type	Description
UID	Long Integer	Unique identifier for shoreline segment
Value	Auto Number	Auto Number
Shoretype	Short Integer	Shoreline type code, Values = 10 = "swamp forest", 20 = "marsh", 30 = "sediment bank", 40 = "modified" and 99 = "miscellaneous" for segments ending at county boundaries or other segments that end at the upstream delineation of a feature.
Field_Check	Short Integer	Designates if shoreline type has been field checked, Values =, 0 = has not been checked, 1 = needs to be checked, 2 = has been checked. Default = 0.
County	Text (15)	County Name
Length	Double	Length of shoreline segment in feet (calculated). Values = 0 to _
Imagesource	Text (50)	Source of the imagery, i.e. Carteret County Orthophoto
Fdate	Date	Feature date (date shoreline segment was published)
ImageDate	Text	Date image was captured if known
FCode	Long Integer	Feature code for stream mapping, Value = 56600 (coastline)
Resolution	Text (15)	Resolution of imagery used for digitizing

Goal oriented tasks of ESMP

1. Quantifying how many miles of estuarine shoreline are in NC (current estimate 4,000 - 12,000 miles)

2. Characterizing shoreline type
   - How many miles of marsh, swamp forest, etc.?
   - How many miles of shoreline are modified?
   - Location of these types

3. Quantify number of structures
   - Coverage of public trust waters
   - Ecosystem function impairment
   - Alternatives to hardening, i.e. living shorelines

Estuarine Shoreline Mapping Project